Recent RFQ Simulations

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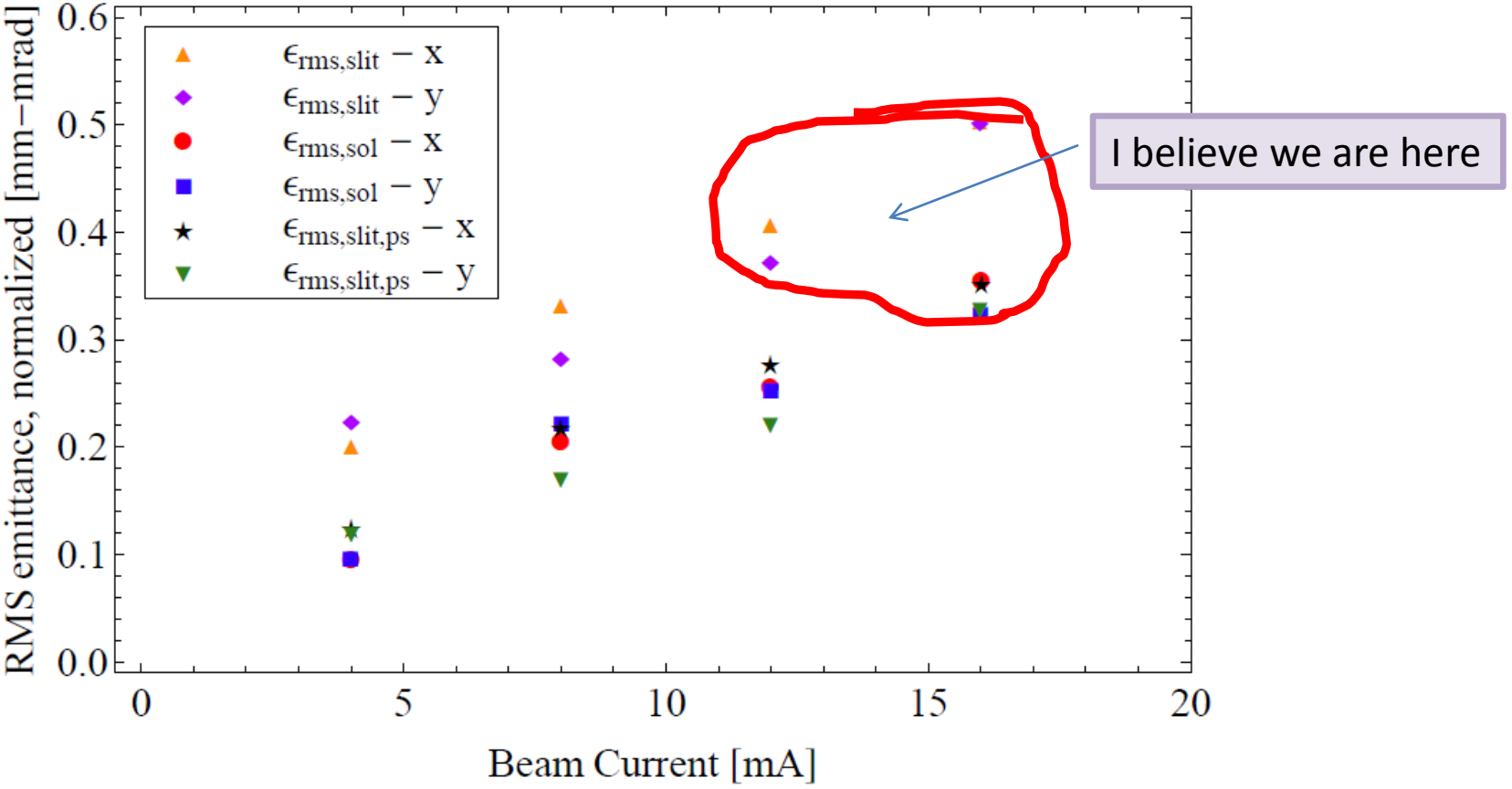
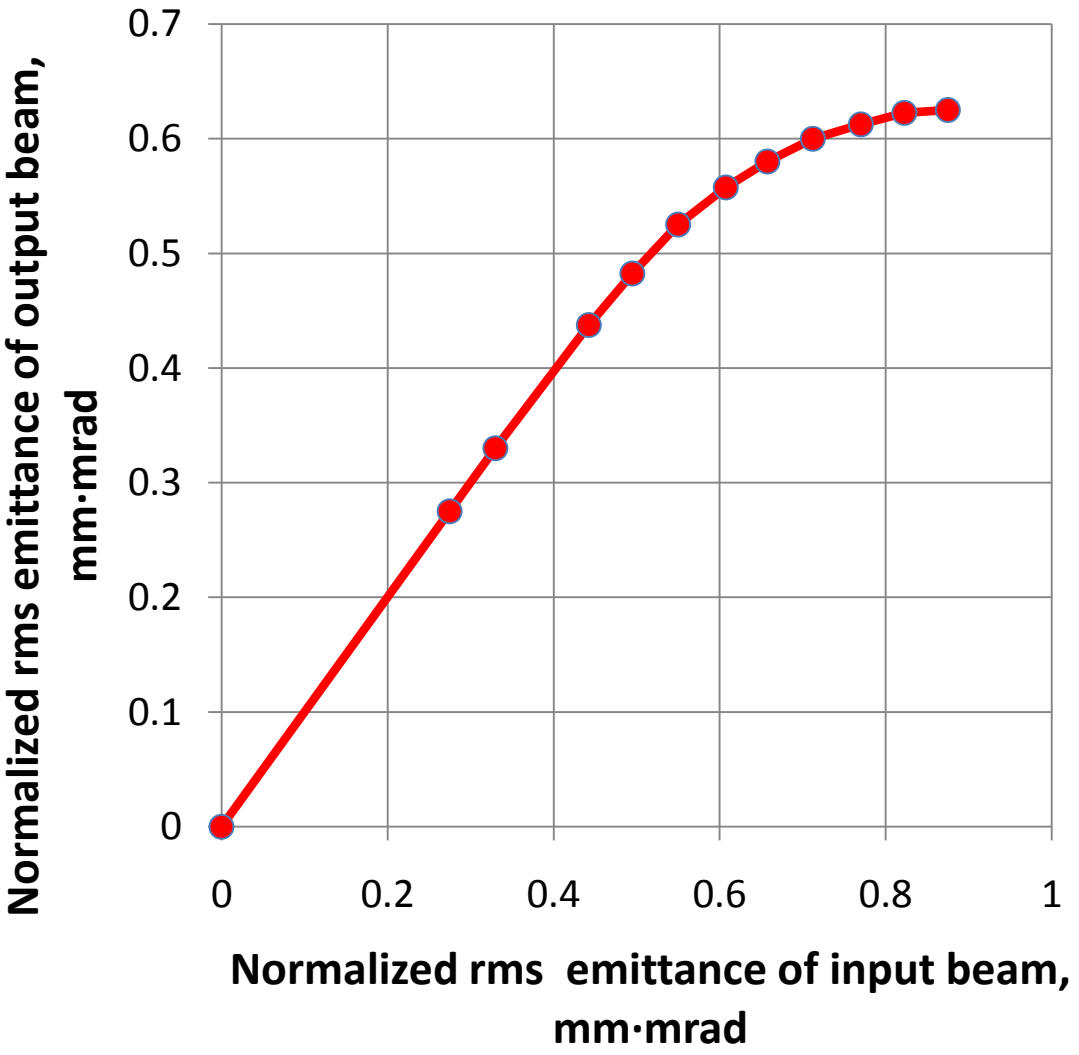
Simulations:

- RFQ output beam emittance vs. input beam emittance
- RFQ transmission vs. intervane voltage
- Output beam parameters vs. input beam matching

Output beam normalized rms emittance after RFQ is 0.37 mm·mrad, basing on Vic's WS measurements and TRACK simulations. Nominal emittance is 0.255 mm·mrad. I assume that this is just because of bigger emittance of the beam from the ion source. According to Wai-Ming measurements we should have input beam emittance 0.3 -0.4 mm·mrad. Note, that the beam current is total on the plot, and that the slit measurements are more trustful since they use universal definition of rms emittance (the same is used in TRACK)

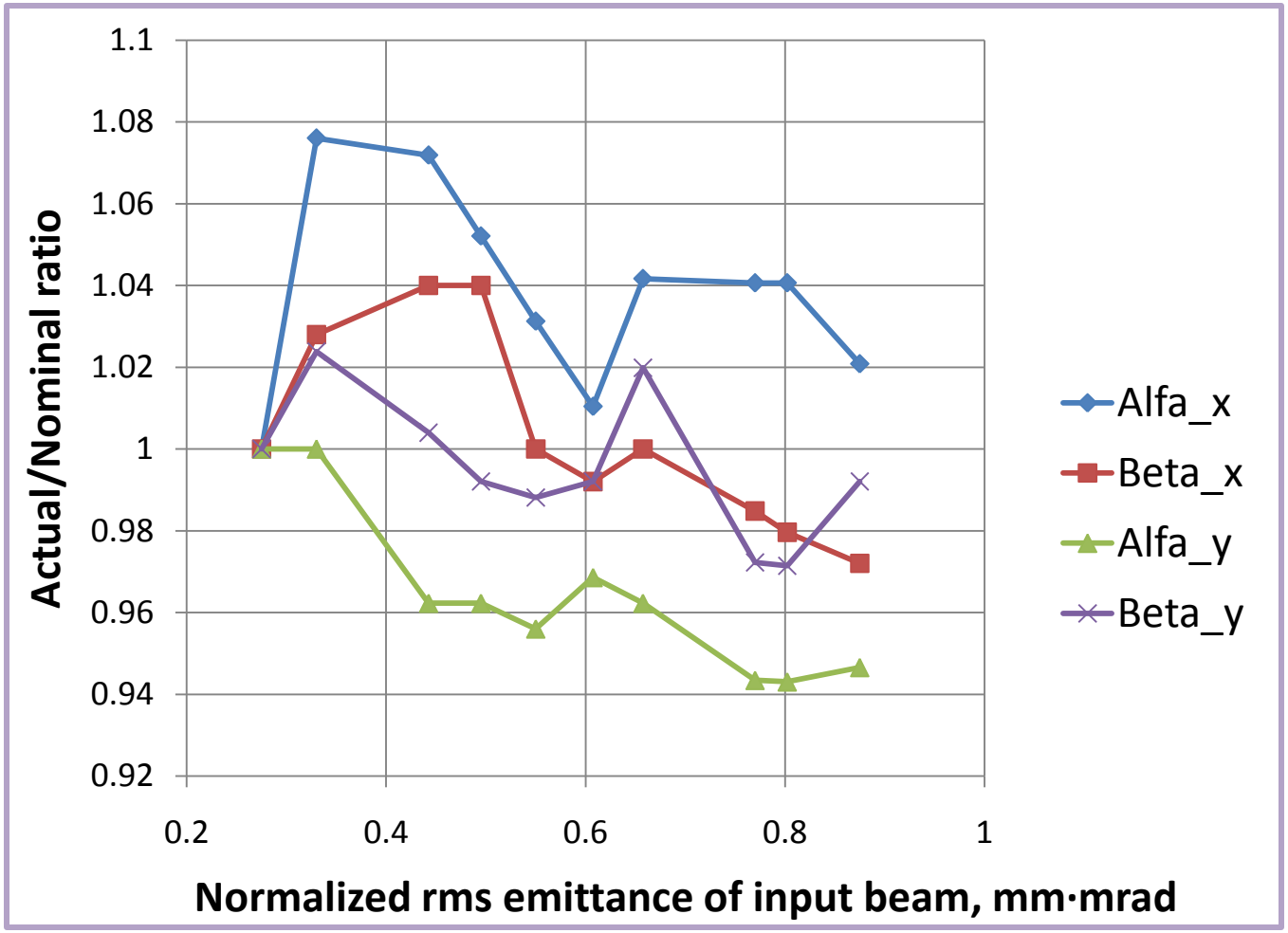




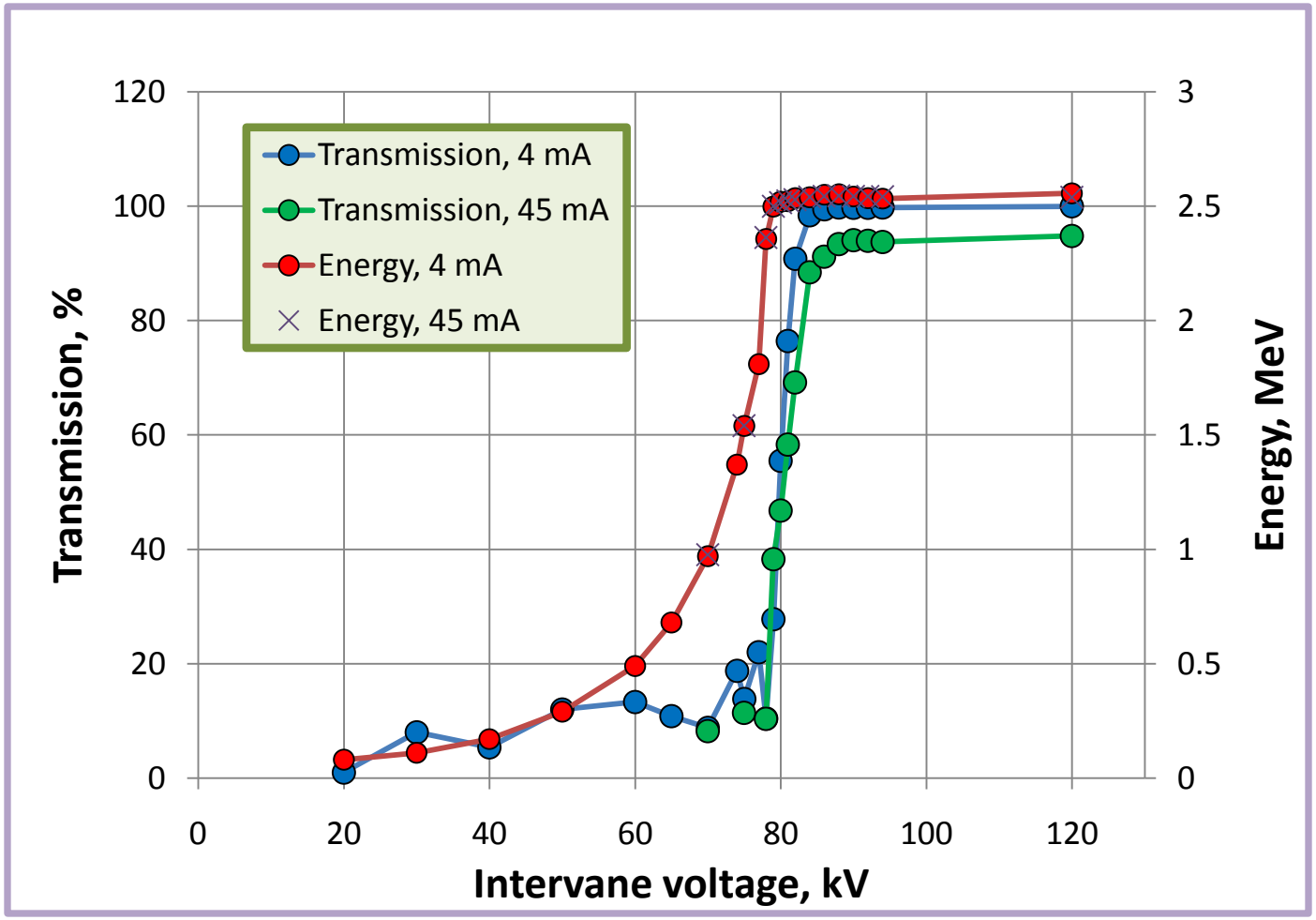
To check this assumption I simulated RFQ with TRACK for different input emittances of matched beam. Beam current was 4 mA which is apparently not true for the beginning of RFQ channel. Nevertheless, the curve is pretty smooth and linear up to ≈ 0.5 mm·mrad. Above this number the beam losses limit output emittance – RFQ acts as a filter.

So, it looks like the bigger emittance after RFQ is just a reflection of bigger emittance from the IS.

Output beam parameters vs. input emittance

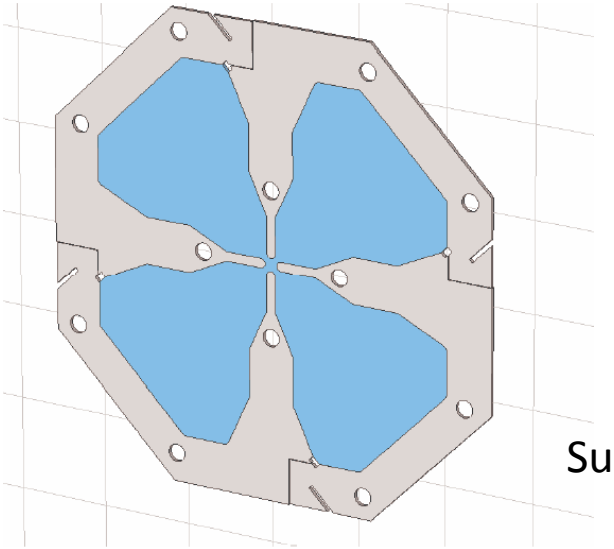


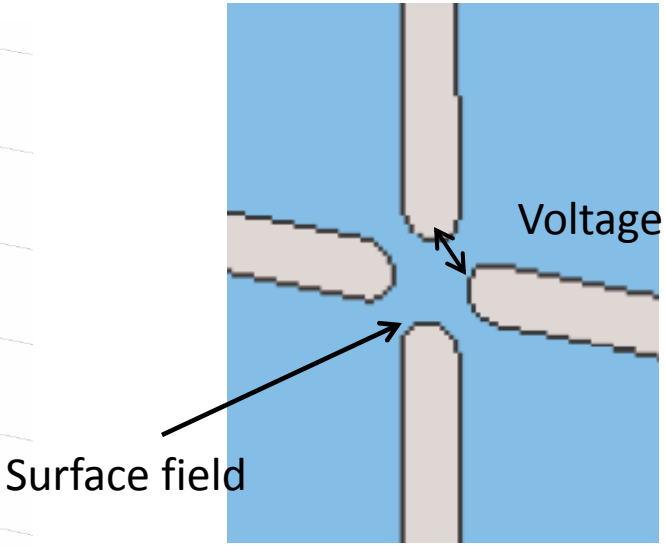
This is RFQ transmission and output energy vs. intervane voltage as simulated by TRACK. Nominal intervane voltage is 90.4 kV. Beam energy is average energy over all particles. Transmission is calculated for accelerated particles, i.e. within $\Delta W / W_{nom} = 0.05$ range. So, "transmission" defines how much particles are captured in accelerations. Transmission in terms of beam current is still almost 100%.

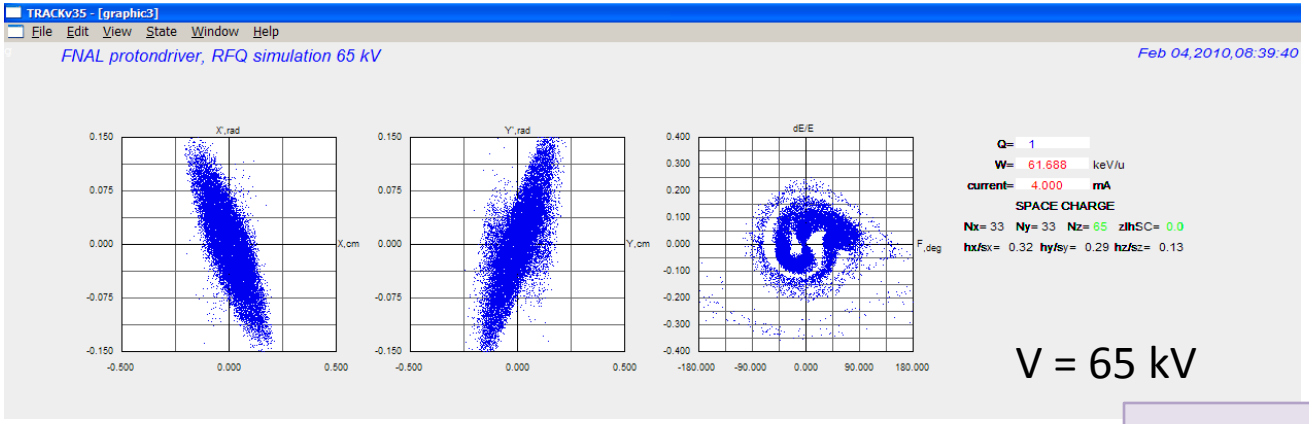


RF power threshold

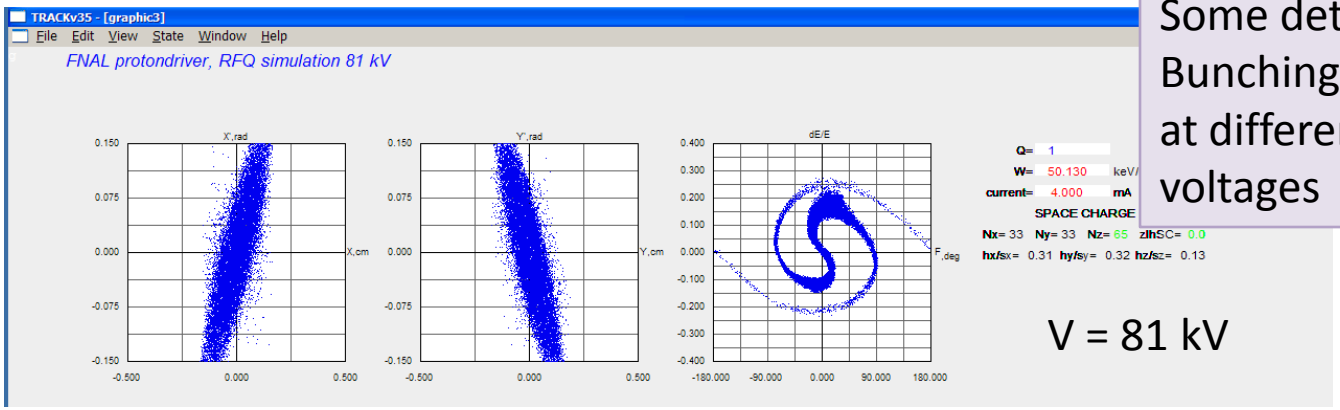
In MWS simulations intervane voltage of 90.4 kV corresponds to 250 kW of pulsed RF power if estimation is based on nominal voltage or 244 kW if estimation is based on nominal maximal surface field of 330 kV/cm. Both estimations don't include tip vane modulation, slug tuners, power couplers and fast tuner.





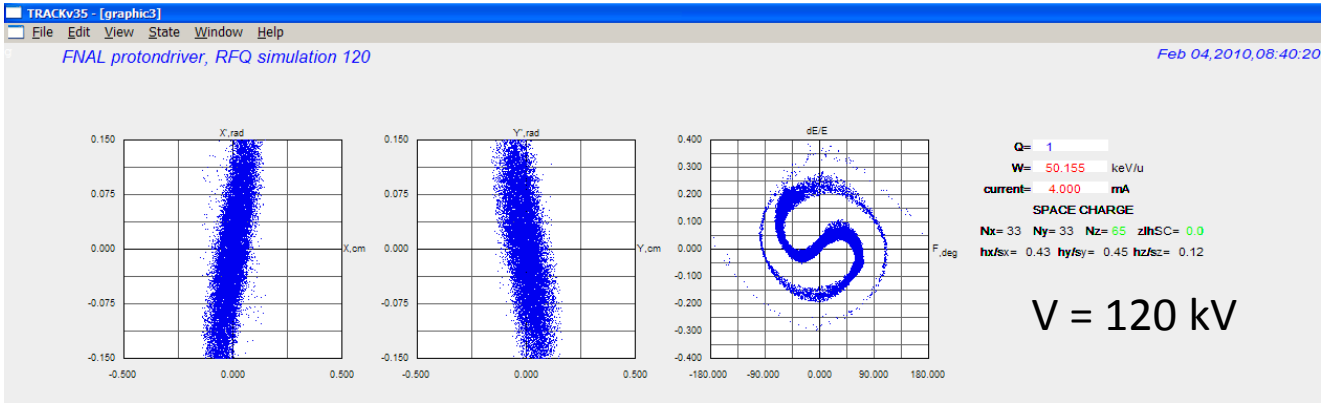


V = 65 kV



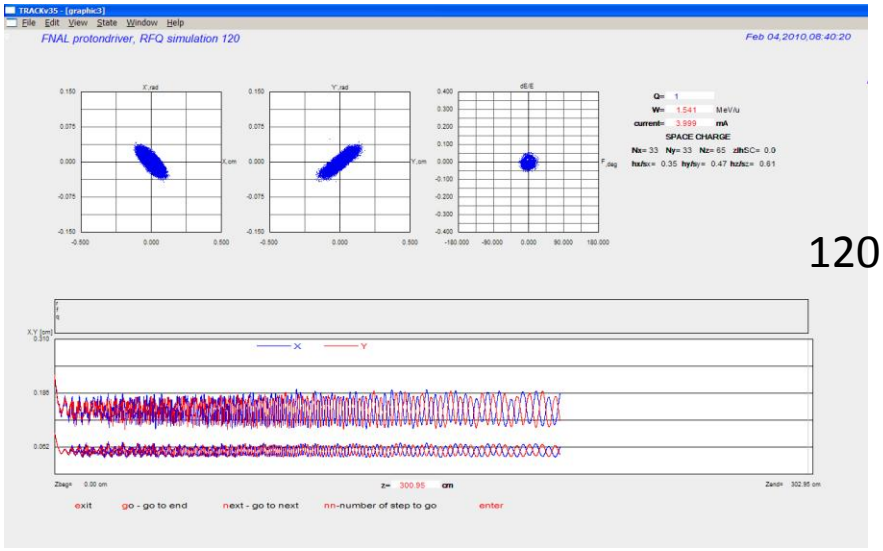
V = 81 kV

Some details of beam dynamic
Bunching and capturing
at different intervane
voltages

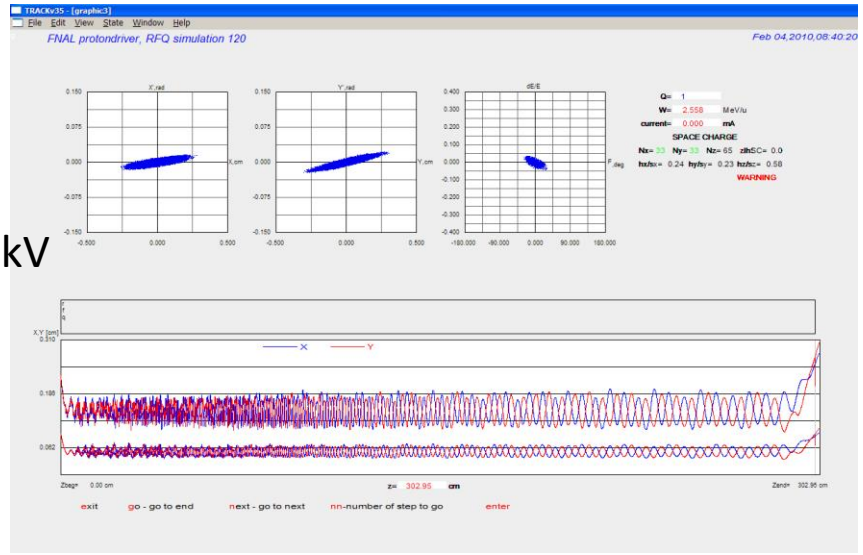


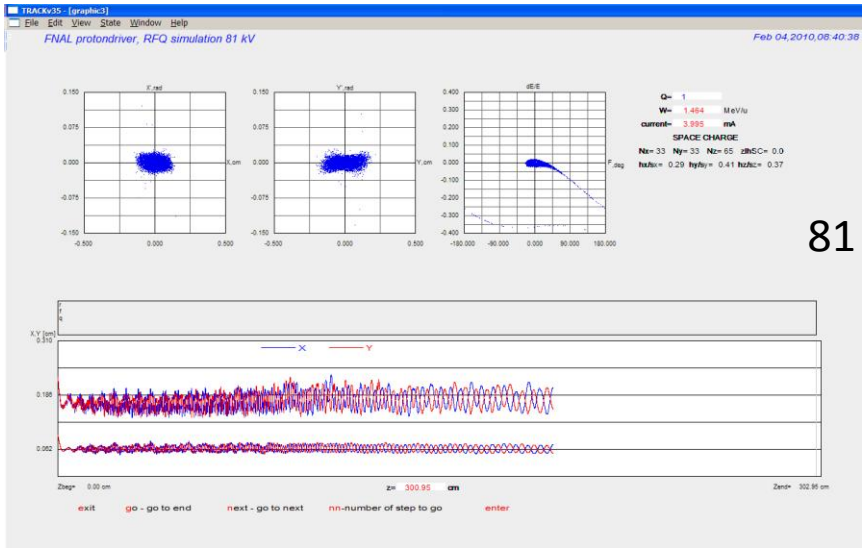
V = 120 kV

Acceleration and final result at V=120 kV and V=81 kV
Notice different longitudinal ellipses and similar transverse ones.

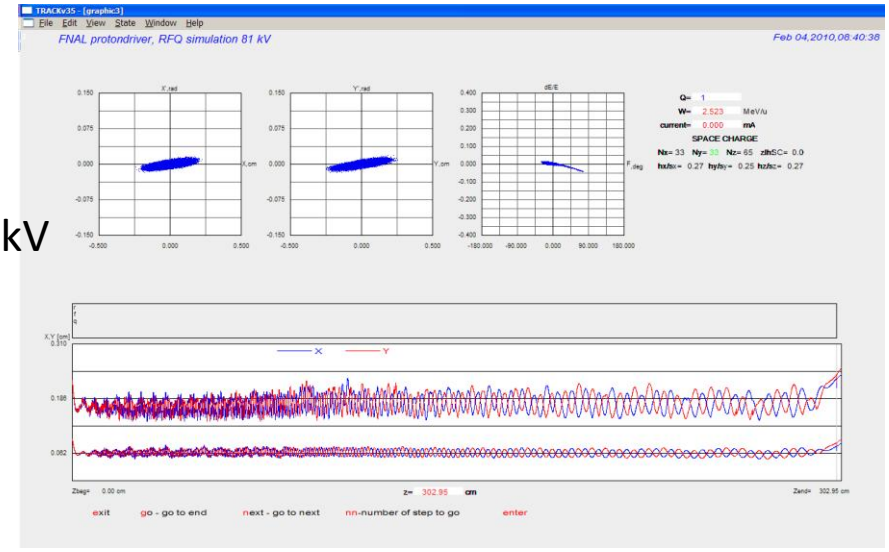


120 kV

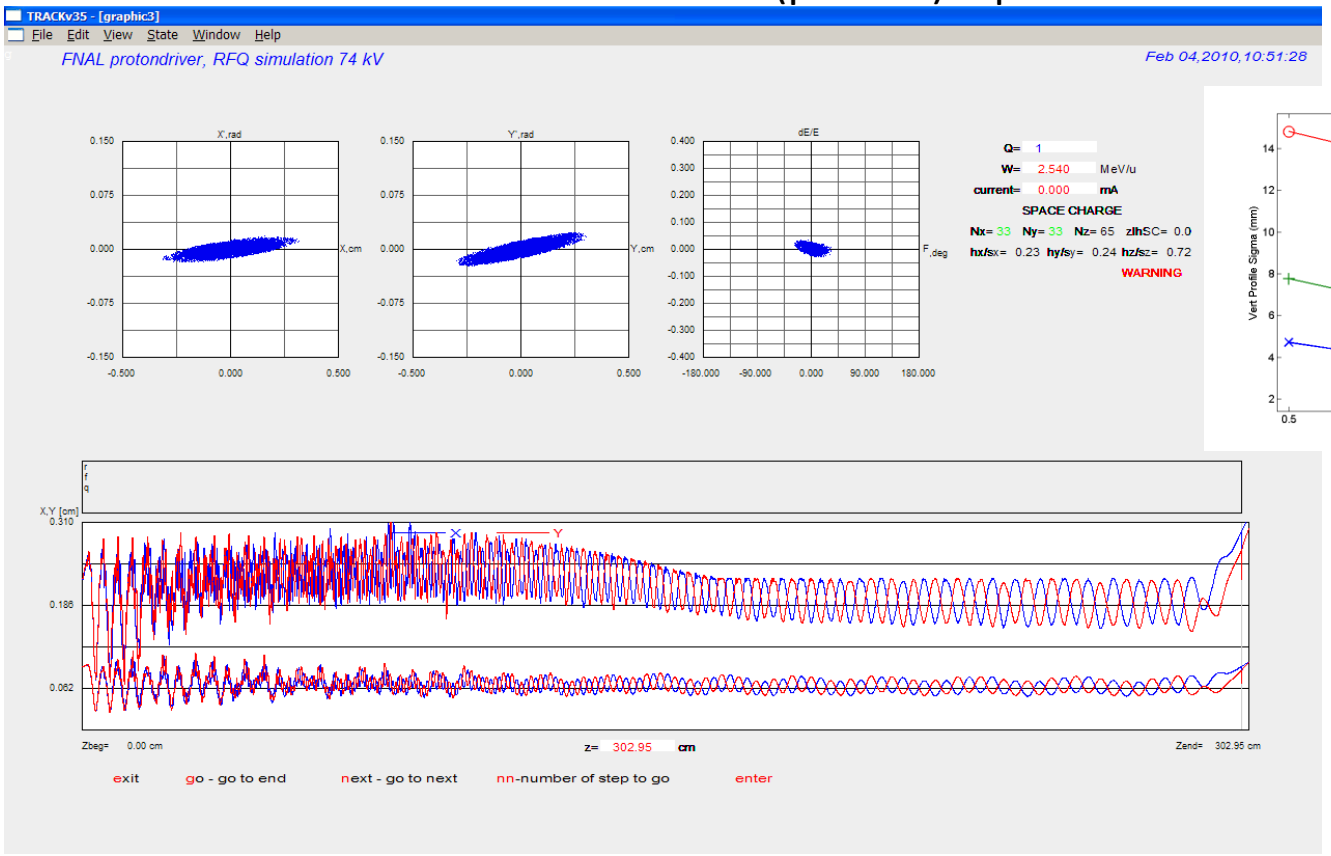


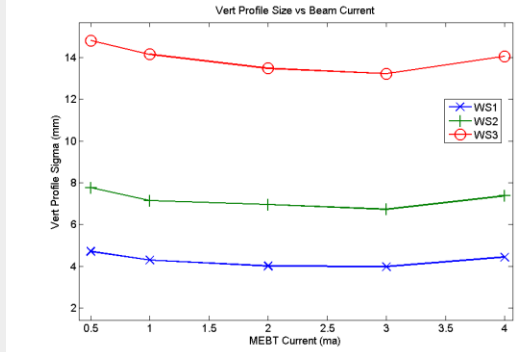


81 kV



Unmatched (parallel) input beam



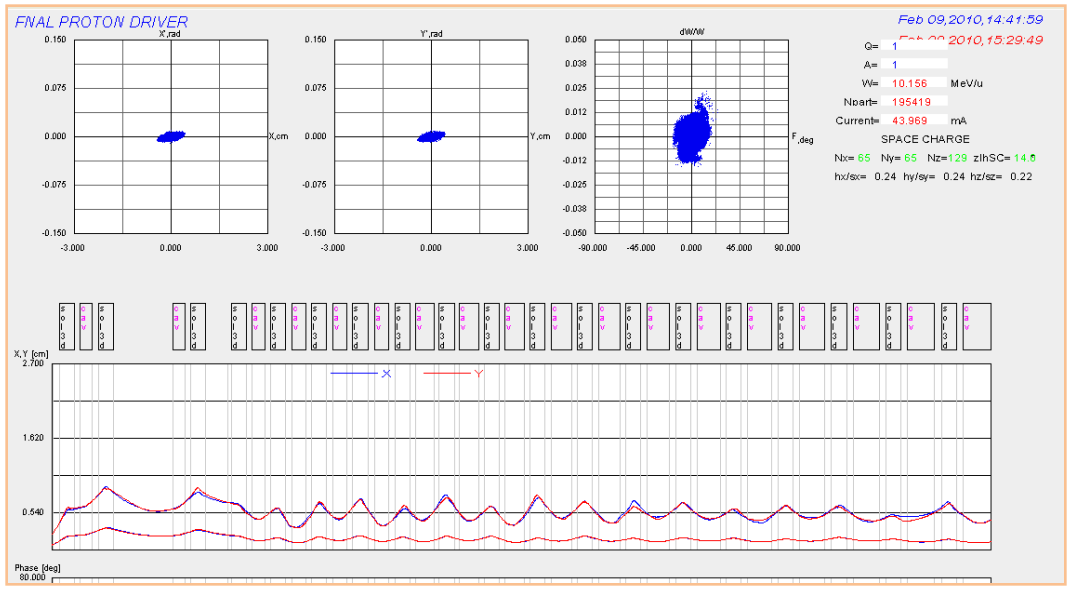


Output: α_x = -0.87, β_x = 0.024
α_y = -1.42, β _y = 0.023

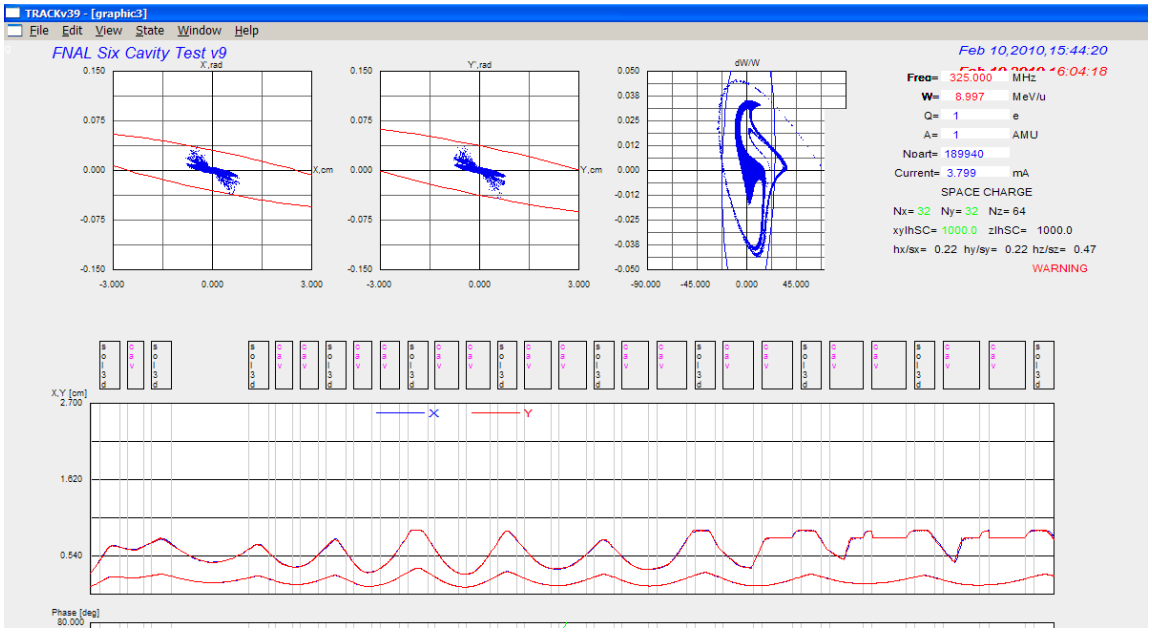
(β in cm/rad)

Transmission 91%

Output with matched beam:
α_x = -1, β_x = 0.025
α_y = -1.5, β _y = 0.025



Base RT section design



Cavity doublets.